University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

U.S. National Park Service Publications and Papers

National Park Service

2008

Developing Integrated Assessments for National Capital Region Network Parks: An Example from Rock Creek Park

Lisa N. Florkowski
University of Maryland

William C. Dennison
University of Maryland

Todd R. Lookingbill
University of Maryland

Tim J.B. Carruthers
University of Maryland

Jane M. Hawkey
University of Maryland

See next page for additional authors

Authors
Lisa N. Florkowski, William C. Dennison, Todd R. Lookingbill, Tim J.B. Carruthers, Jane M. Hawkey, and Shawn L. Carter

Published in Weber, Samantha, and David Harmon, eds. 2008. Rethinking Protected Areas in a Changing World: Proceedings of the 2007 GWS Biennial Conference on Parks, Protected Areas, and Cultural Sites. Hancock, Michigan: The George Wright Society.

Developing Integrated Assessments for National Capital Region Network Parks: An Example from Rock Creek Park

Lisa N. Florkowski, Integration and Application Network, University of Maryland Center for Environmental Science, 2020 Horns Point Road, Cambridge, MD 21613; lflorkow@umces.edu

William C. Dennison, Integration and Application Network, University of Maryland Center for Environmental Science, 2020 Horns Point Road, Cambridge, MD 21613; dennison@umces.edu

Todd R. Lookingbill, Appalachian Laboratory, University of Maryland Center for Environmental Science, 301 Braddock Road, Frostburg, MD 21532 tlooking@al.umces.edu

Tim J.B. Carruthers, Integration and Application Network, University of Maryland Center for Environmental Science, 2020 Horns Point Road, Cambridge, MD 21613; tcarruth@umces.edu

Jane M. Hawkey, Integration and Application Network, University of Maryland Center for Environmental Science, 2020 Horns Point Road, Cambridge, MD 21613; hawkey@umces.edu

Shawn L. Carter, National Capital Region Inventory & Monitoring Program, National Park Service, 4598 MacArthur Boulevard NW, Washington, DC 20007; Shawn_Carter@nps.gov

Rock Creek Park in context

The National Capital Region Network (NCRN) contains 11 parks within the District of Columbia, Maryland, Virginia, and West Virginia (Figure 1a): Antietam National Battlefield (ANTI), Catoctin Mountain Park (CATO), Chesapeake and Ohio Canal National Historical Park (CHOH), George Washington Memorial Parkway (GWMP), Harpers Ferry National Historical Park (HAFE), Manassas National Battlefield Park (MANA), Monocacy National Battlefield (MONO), National Capital Parks–East (NACE), Prince William Forest Park (PRWI), Rock Creek Park (ROCR), and Wolf Trap National Park for the Performing Arts (WOTR). These parks are some of the most visited in the National Park Service (NPS) system due to the urban context in which many of the parks are located, as well as the proximity to the major population centers of the District of Columbia and Baltimore (Carter et al. 2006). The integrated assessment focuses on Rock Creek Park, one the most urban of the NCRN parks.

Rock Creek Park (Figure 1b) is located in the heart of the District of Columbia and is one of the largest forested, urban parks in the United States. It contains a unique combination of natural, historical and recreational features. The mixed deciduous forests, streams, and sensitive floodplain communities of the park represent a largely natural system surrounded by high-density urban development. A land use analysis of Rock Creek Park shows that the park is 80% forested and 12% developed; the surrounding area is 21% forested and 71% developed (Townsend et al. 2006). Because of this dramatic difference in land use, Rock Creek Park has been described as "an island of forest in a sea of development." This dense urban development impacts park resources through traffic, flooding, chemical and

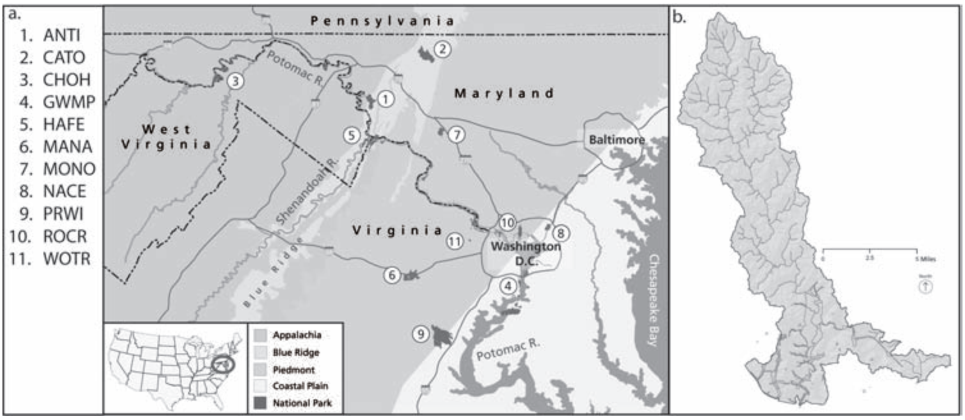


Figure 1. Rock Creek Park in a (a) regional and (b) watershed context (NPS 2006).

biological pollution of park streams, introductions of invasive species, recreational demand, dumping, collecting, creation of unauthorized trails, and boundary encroachments (Carter et al. 2006).

Developing thresholds for diverse vital signs

The integrated assessment of Rock Creek Park is based upon Inventory & Monitoring (I&M) data collected in the 2005-2006 field seasons. Within Rock Creek Park, the I&M Program is collecting data on 21 vital signs (62 metrics) in four categories:

- Air quality and climate: ozone, wet deposition, visibility and particulate matter, mercury deposition, weather (11 metrics);
- Water quality and hydrology: surface water dynamics, water chemistry, nutrient dynamics, aquatic macroinvertebrates, physical habitat index (18 metrics);
- Biodiversity: invasive/exotic plants, forest insect pests, forest vegetation, fishes, amphibians, land birds, white-tailed deer, rare/threatened/endangered species and communities (23 metrics); and,
- Ecosystem pattern and process: land cover/land use, and landscape condition (10 metrics).

Linking management objectives to thresholds

Each of the vital signs listed above is associated with one or more management objectives (Figure 2). These objectives are laid out in the protocols written by the networks. In order to use the I&M data to determine whether management objectives are met (Mehaffey et al. 2005), it is necessary to evaluate the data relative to pre-determined threshold values or assessment points. These values can be set by scientific journals, regulations, or can be based on expert opinion (Bertollo 1998; Shear et al. 2003; Pantus and Dennison 2005). Our goal for threshold development is to use ecologically relevant thresholds. However, until these thresholds can be developed, regulatory values are used as a substitute to measure park health. According to Biggs (2004), thresholds serve as research hypotheses, connections to

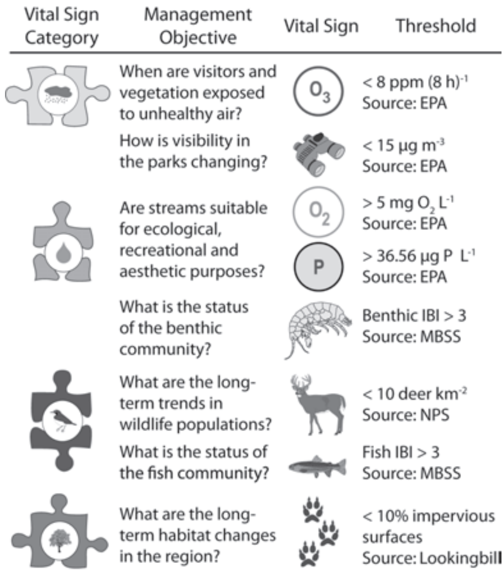


Figure 2. The link between management objectives and thresholds. Example management objectives are listed for each vital sign category. A vital sign that pertains to the management objective is listed. The threshold that has been developed for one of the metrics within that vital sign has been listed in the final column.

system drivers that influence ecosystems, and tangible, realistic environmental goals. It is important to note that these threshold values do not have to be permanent. If management goals change or new research is published, the threshold can be modified accordingly (Jensen et al. 2000; Pantus and Dennison 2005). These flexible environmental thresholds are a key part of the adaptive management cycle. Adaptive management requires approaching management as an experiment that relies on sound, responsive monitoring to inform future management decisions (Boesch 2000).

Threshold development is currently an on-going process for the NCRN. At this point, threshold values have been determined for eight of the 21 vital signs that pertain to Rock Creek Park. In order to develop these thresholds, we began by looking at regulatory values for the "air quality and climate" and "water quality and hydrology" categories. Regulatory values are readily available for these two vital sign categories because the quality of these natural resources is federally regulated for human health reasons. At Rock Creek Park, the two thresholds that have been developed for the ozone and "visibility and particulate matter" vital signs are Environmental Protection Agency (EPA) National Ambient Air Quality Standards (NAAQS) (EPA 1990). Those vital signs that do not have thresholds are either being used to explain variation in other vital signs (e.g., weather) or there has yet to be a link between ecological effect and the metrics (e.g., mercury deposition).

For the water quality and hydrology category, 10 thresholds have been developed. Seven of the thresholds are regulatory: five are District of Columbia Municipal Regulations (DC 2006) and two are EPA National Recommended Water Quality Criteria. The remaining three thresholds are ecologically relevant thresholds. One was developed by Hilderbrand et al. (2006), one was developed by the Maryland Department of Natural Resources (MDDNR) Maryland Biological Stream Survey (MBSS), and the third is an EPA Nutrient Criteria that is suggested to prevent eutrophication. Ultimately, developing these ecologically relevant thresholds is the goal for all of the thresholds used in the integrated assessment.

Thresholds for the Biodiversity category are difficult to develop. In many cases the monitoring data that is being collected is species assemblage information. What needs to be determined is what species assemblages are considered "healthy" or whether "keystone" species are present. To develop these thresholds, scientific research projects may need to be conducted or many years of monitoring data may need to be collected to determine what assemblages are present. Currently, two thresholds have been developed; one is from the MBSS and the second has been developed by NCRN staff.

For the ecosystem pattern and process category, four thresholds have been developed from expert opinion. The remaining metrics require trend information to develop thresholds. Because the vital signs in this category are measured on a five-year basis, it will require at least five more years of monitoring data in order to develop these thresholds.

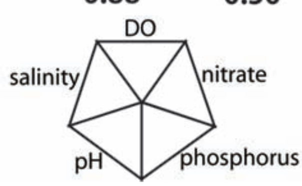
Using the thresholds that are currently available it is possible to assess Rock Creek Park with the caveat that more indicators and thresholds could be incorporated at a later date. The assessment framework that has been developed is easy to adjust to add more vital sign metrics as thresholds become available. According to Pantus and Dennison (2005), indices of ecosystem health which are based upon more indicators generally incorporate more information. Therefore, as the remaining thresholds are developed, more vital sign metrics will be added to the integrated assessment.

Assessing threshold attainment in space and time

The next step in the assessment is to determine whether the resource, as measured by the monitoring data, meets the management goal, as quantified by the threshold value. To do this, monitoring data is directly compared to the threshold value. For example, monthly water quality measurements are made at the Pinehurst Branch monitoring location (Figure 3). Information is collected at this site for both the water chemistry and nutrient dynamics vital signs. Thresholds and monitoring data are listed for five vital sign metrics, and the monitoring data that do not meet the threshold value are colored gray (Figure 3).

Figure 3. Monitoring data and thresholds from Rock Creek Park. Example data set is from the Pinehurst Branch monitoring location. Data colored gray do not meet the threshold value.

	Dissolved O_2 mg L^{-1}	NO_3 mg L^{-1}	PO_4 mg L^{-1}	pH	Salinity
Threshold	> 5.00	< 2.00	< 0.037	6.00 - 8.50	< 0.25
10/4/2005	7.80	0.40	0.69	7.50	Not Reported
11/3/2005	6.56	1.20	1.23	7.58	Not Reported
12/8/2005	9.01	0.30	0.41	7.47	1.10
1/3/2006	5.58	2.50	0.44	7.67	0.20
2/14/2006	11.88	3.00	0.48	7.67	0.70
3/8/2006	7.64	3.10	0.15	8.30	0.30
4/4/2006	5.98	0.70	Absent	8.01	0.20
5/4/2006	3.94	2.80	0.61	7.75	0.20
	0.88	**0.50**	**0.00**	**1.00**	**0.50**



Excellent A ≤ 1.00
Good B ≤ 0.80
Poor C ≤ 0.60
Degraded D ≤ 0.40
Very Degraded F ≤ 0.20

To compare sites within Rock Creek Park, the percentage of time a site meets the thresholds is calculated. Pinehurst Branch receives a score of 0.50 for nitrate concentration, where a score of one means that the site always meets the threshold (Figure 3). Normalizing the data by the percentage of time the threshold is met also allows vital sign metrics to be compared that have different units and different sampling frequency. In this way we can compare nutrient dynamics (mg L^{-1}), which are sampled monthly, with white-tailed deer (deer/ha), which are sampled annually. Another method of measuring attainment of thresholds would be to assign the vital sign metric a zero if any sampling periods exceeded the threshold value and a one only if the metric was always within the threshold, as would be used if any of the metrics used in the assessment indicated a system collapse after one instance of exceedance. Because of the intense urban pressures the NCRN parks experience, it is unlikely that all metrics will meet the threshold at all sampling periods. By using the percentage of time assessment criteria, it is possible to create a continuum of site conditions to determine where management should focus restoration or protection efforts. Using a binary (one or zero) scale only would not provide the same amount of information as the percentage scale.

Calculation of park ecosystem health

There are different methods for combining the vital sign metric scores into a condition assessment. One method is to combine scores across vital signs into a site condition score. As discussed previously, this assessment score allows management to determine where within a park resources are needed for restoration and protection. A second method of combining metric scores is within vital signs. In this method, the mean of metric scores for the entire park can be calculated to create a park-level vital sign score. This score potentially can be compared with the vital sign score other parks receive to place a particular park along a gradient of park health. The vital sign score can be compared not only within a Network, but also between Networks.

The next step in the integrated assessment for Rock Creek Park is to combine vital sign scores into a park health score (Figure 4). To calculate this score, all the vital signs within a category are combined to create a vital sign category score. In Rock Creek Park, the vital sign metrics for which thresholds are available are averaged into vital sign scores. These vital sign scores are then averaged to calculate a vital sign category score. For example, the water chemistry score is 0.92, the nutrient dynamics score is 0.04, and the aquatic macroinvertebrates score is 0.52. These scores are then averaged to calcu-

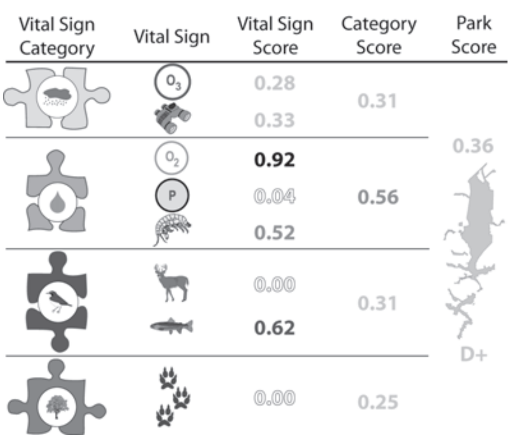


Figure 4. Representation of integrated assessment approach. Vital sign scores are calculated by averaging vital sign metric scores (not shown). These vital sign scores are averaged to create a category score. The category scores are then averaged to create a park health score.

late the Water Quality and Hydrology score of 0.56. A similar method is used to calculate the scores for the three remaining vital sign categories. These category scores are then averaged together to calculate the final score for Rock Creek Park. This numeric score is not useful if management and the public cannot easily relate to it. The numeric score can be translated into a letter grade using the same scale as the recent Chesapeake Bay Report Card (Ecocheck 2007). Using that scale, Rock Creek receives a D+ for this preliminary assessment of ecosystem health.

Application to other parks and networks

The method for calculating the park score was chosen to facilitate comparison between I&M Networks. Due to the wide range of geomorphologic structures, habitats, fauna and flora throughout the nation, individual networks are measuring different metrics and vital signs. Regional comparisons within networks will be most efficient at the vital sign level (e.g. aquatic macroinvertebrates) as this will provide the most detailed information about the relative status of the local resources within a network. Broad scale comparisons, however, will best be carried out at the vital sign category level (e.g. "water quality and hydrology") as there will always be some metrics at all parks within these generic classes. For these reasons, this hierarchical approach to an integrated assessment for vital signs monitoring can provide local detail as well as regional or national-level synthesis.

References

Bertollo, P. 1998. Assessing ecosystem health in governed landscapes: A framework for developing core indicators. *Ecosystem Health* 4:1, 33–51.

Biggs, H.C. 2004. Promoting ecological research in national parks—A South African perspective. *Ecological Applications* 14:1, 21–24.

Boesch, D.F. 2000. Measuring the health of the Chesapeake Bay: Toward integration and prediction. *Environmental Research* 82:2, 134–142.

Carter, S., T. Lookingbill, J. Hawkey, T. Carruthers, and W.C. Dennison. 2006. *A Conceptual Basis for Natural Resource Monitoring.* Washington, D.C.: Inventory & Monitoring Program, Center for Urban Ecology, National Park Service.

Dennison, W.C., T. Lookingbill, T. Carruthers, J. Hawkey, and S. Carter. In press. An eye-opening approach to developing and communicating integrated environmental assessments. *Frontiers in Ecology.*

DC [District of Columbia]. 2006. Water Quality Standards. 21 District of Columbia Municipal Regulations Ch. 11. On-line at www.epa.gov/waterscience/standards/wqslibrary/dc/.

Ecocheck. 2007. *Chesapeake Bay Habitat Health Report Card: 2006.* Integration and Application Network, University of Maryland Center for Environmental Science, Ecocheck (NOAA-UMCES Partnership). On-line at www.eco-check.org/reportcard/chesapeake/.

EPA [Environmental Protection Agency]. 1990. *Clean Air Act.* 40 CFR part 50. On-line at www.epa.gov/air/criteria.html.

Hilderbrand, R.H., R.L. Raesly, and D.M. Boward. 2006. *National Capital Region Network Biological Stream Survey Protocols.* Washington, D.C.: National Capital Region Network, National Park Service.

Jensen, M.E., K. Reynolds, J. Andreasen, and I.A. Goodman. 2000. A knowledge-based approach to the assessment of watershed condition. *Environmental Monitoring and Assessment* 64:1, 271–283.

Mehaffey, M.H., M.S. Nash, T.G. Wade, D.W. Ebert, K.B. Jones, and A. Ranger. 2005. Linking land cover and water quality in New York City's water supply watersheds. *Environmental Monitoring and Assessment* 107:1/3, 29–44.

Pantus, F.J., and W.C. Dennison. 2005. Quantifying and evaluating ecosystem health: A case study from Moreton Bay, Australia. *Environmental Management* 36:5, 757–771.

Shear, H., N. Stadler-Salt, P. Bertram, and P. Hovatin. 2003. The development and implementation of indicators of ecosystem health in the Great Lakes basin. *Environmental Monitoring and Assessment* 88:1/3, 119–152.

Townsend, P.A., R.H. Gardner, T.R. Lookingbill, and C.C. Kingdon. 2006. *National Capital Region Network Remote Sensing and Landscape Pattern Protocol for Long-term Monitoring of Parks.* Washington, D.C.: National Capital Region Network, National Park Service.

Wazniak, C., M. Hall, C. Cain, D. Wilson, R. Jesein, J. Thomas, T. Carruthers, and W. Dennison. 2004. *State of the Maryland Coastal Bays.* Maryland Department of Natural Resources, Maryland Coastal Bays Program and University of Maryland Center for Environmental Science.